

SEPTEMBER 2019



**WIM #46  
CSAH 1,  
MP 11.4  
WEST  
CONCORD, MN**

**MONTHLY  
REPORT**



*Your Destination...Our Priority*



## WIM Site Location

WIM #46 is located on CSAH 1 near West Concord in Dodge county.

## System Operation

WIM #46 was operational for the entire month of September 2019. Volume was computed using all monthly data.

## System Calibration

WIM #46 was most recently calibrated on 2016-12-19. Table 1 summarizes the front axle weights of class 9s by lane <sup>1</sup>. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation <sup>2</sup>. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

## Summary of Volume Statistics

Total Monthly Volume: 11850 | Passenger Vehicles: 9013 | Heavy Commercial Vehicles: 2837

Monthly Average Daily Traffic (MADT): 400 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 95

See Table 2 for vehicle class breakdown

## Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

**Volume trends.** NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

### Passenger Vehicles (PVs)

**Volume trends.** On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

### Heavy Commercial Vehicles (HCVs)

**Volume trends.** On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

### Overweight HCVs

**Volume trends.** Of a total of 2837 HCVs, 1024 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 10.2% of total monthly volume, and 42.3% of total

monthly HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Sundays. See Figure 3.

The top two overweight violators by class were the class 9 and class 10 vehicles. Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 61% of all overweight vehicles traveling SB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in September.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report <sup>4</sup>.

Using normal load limits, 209 NB vehicles exceeded 88,000 pounds (144 vehicles were Class 9's; 37 vehicles were Class 13's). Of vehicles traveling SB,

113 NB vehicles exceeded 88,000 pounds (90 vehicles were Class 9's; 16 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in September 2019. Data suggests that there were greater numbers of empty Class 9's than fully\_loaded Class 9's traveling NB, while there were more fully\_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully\_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully\_loaded class 10 vehicles.

**Freight Totals.** A total of 32281 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (59.9%) than NB (40.1%). See Table 4 and Figure 11 for more freight information.

**####Infrastructure Considerations Bridge.** Bridge No. 91587 ( a precast pipe arch) is approximately 4.2 miles south of WIM #46. Bridge No. 91588 ( a precast pipe arch) is approximately 7.8 miles south of WIM #46. WIM #46 recorded a total of 11850 vehicles with a combined GVW of 174689 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 3855 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 61.7% of all ESALs were recorded SB while 38.3% was observed NB. In particular, 81% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 60% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

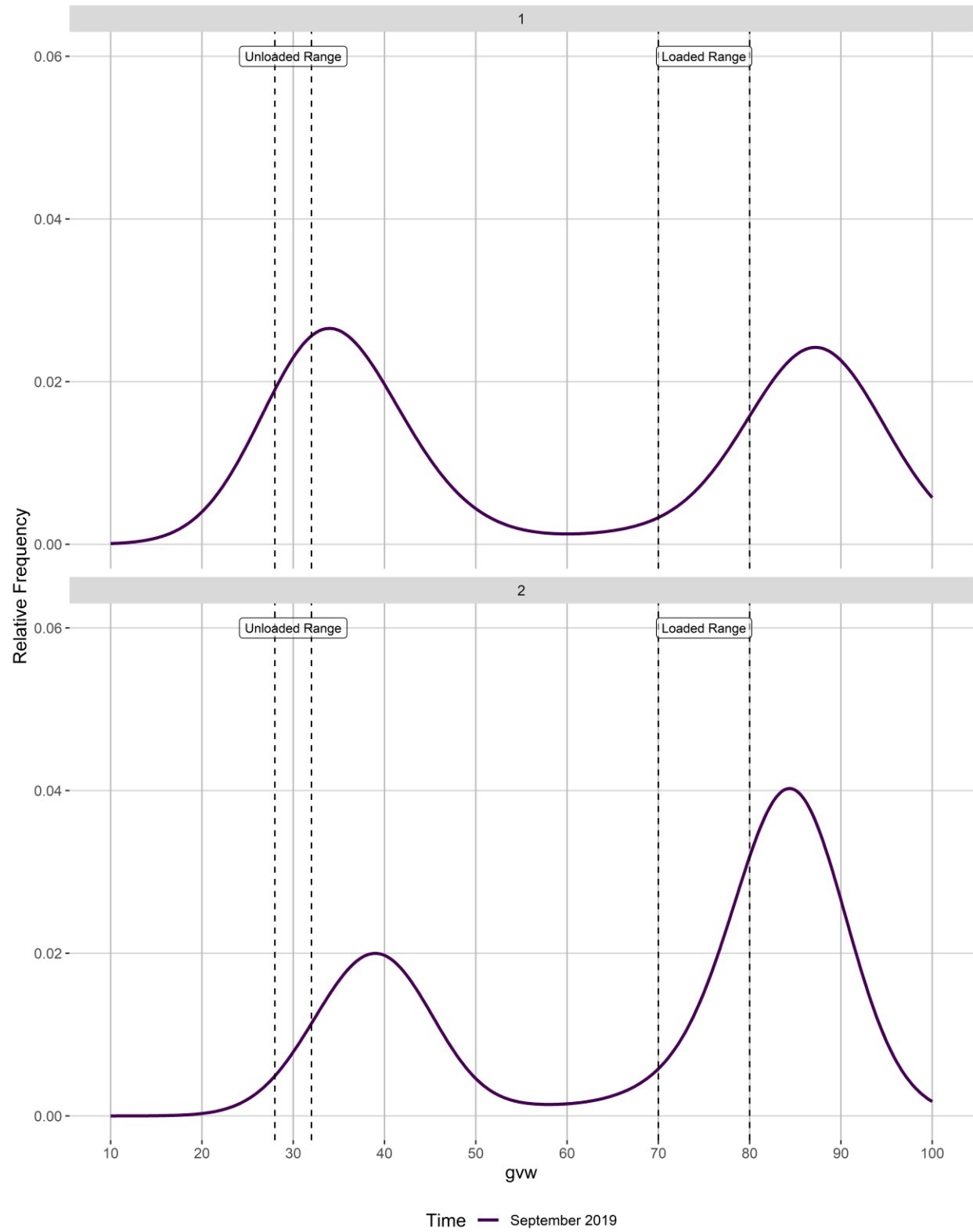
#####WIM monthly reports can be found at:

<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: <http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- <sup>1</sup> Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- <sup>2</sup> Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- <sup>3</sup> An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: [http://www.mrr.dot.state.mn.us/research/seasonal\\_load\\_limits/sllindex.asp](http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp)
- <sup>4</sup> For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

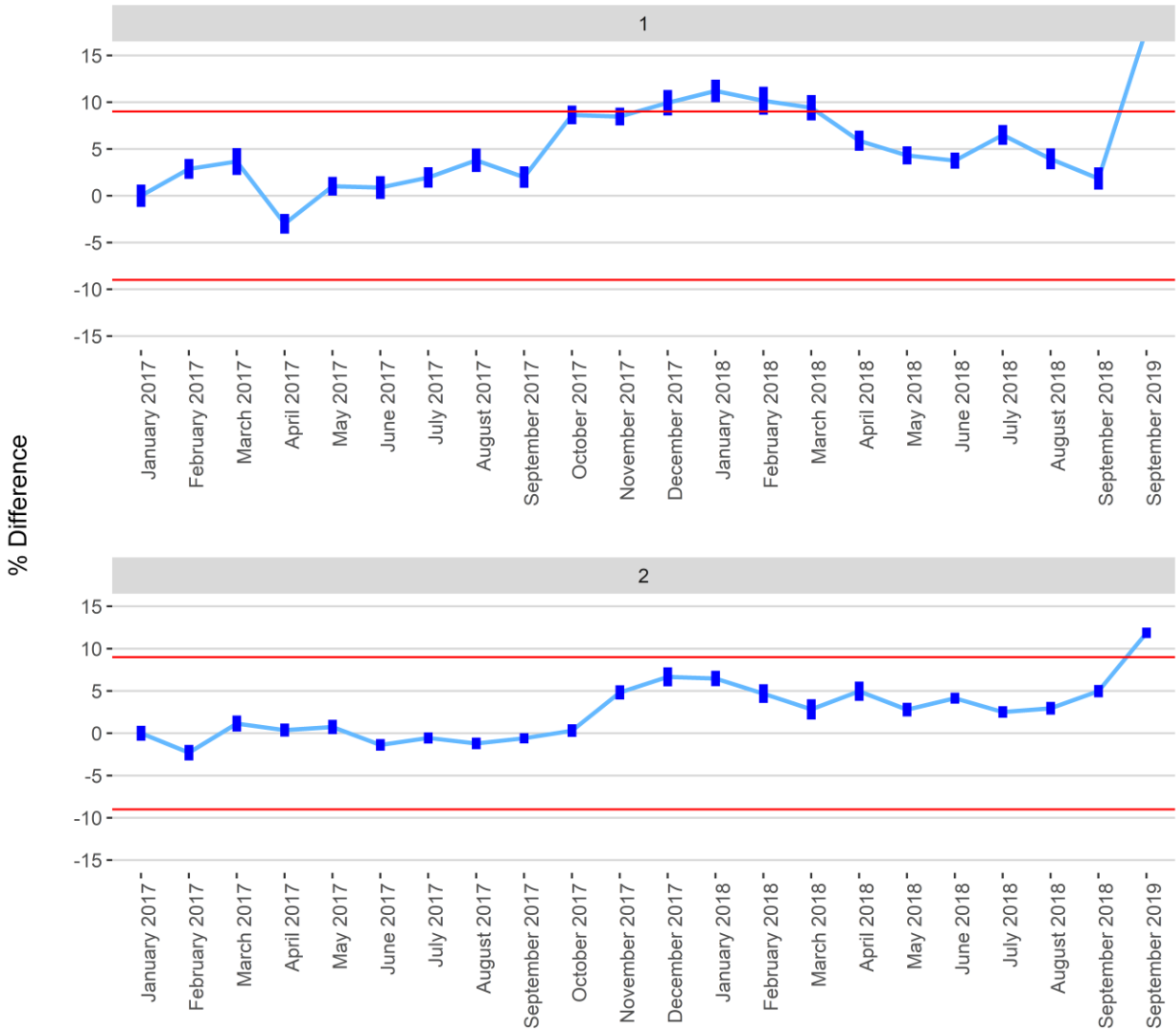
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Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume  
vs. Day of the Week

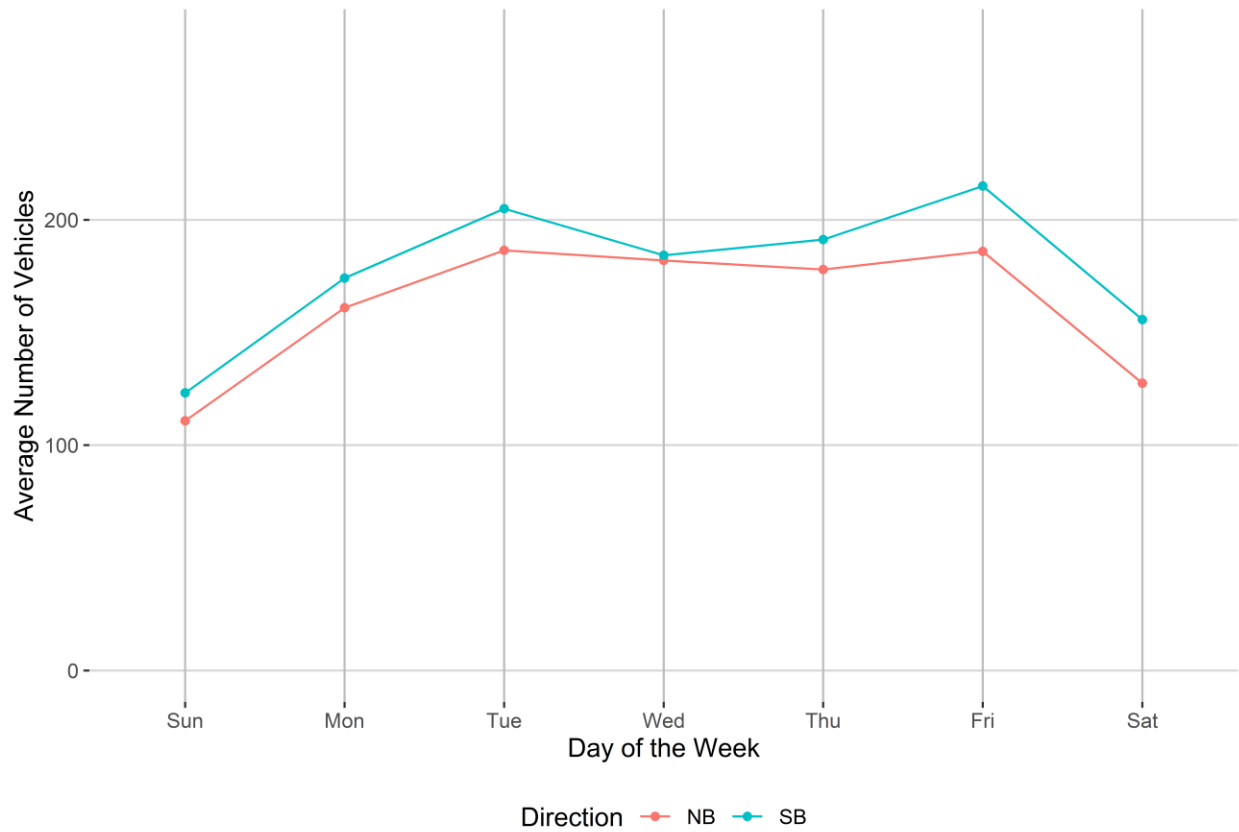


Figure 3 - Average Overweight Vehicle Volume  
vs. Day of the Week

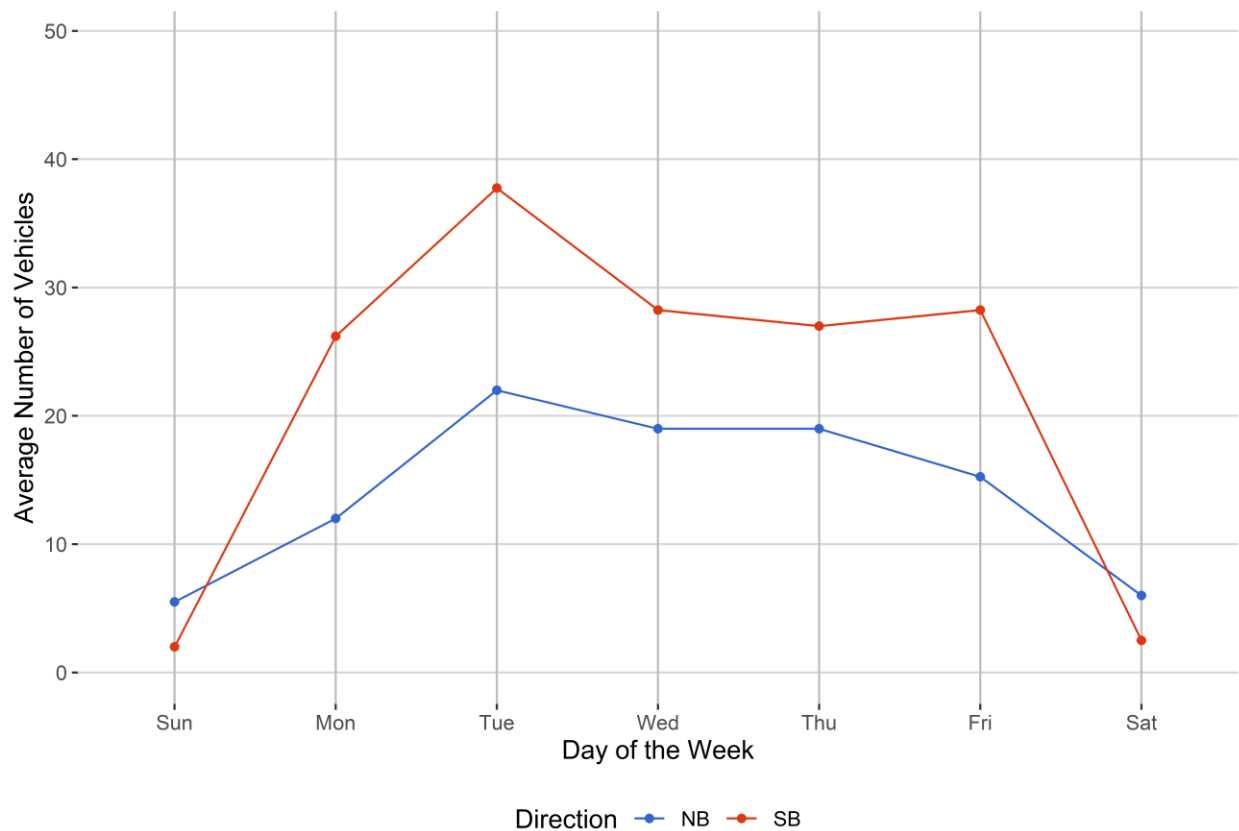


Figure 4 - Passenger Vehicles  
vs. Hour of the Day

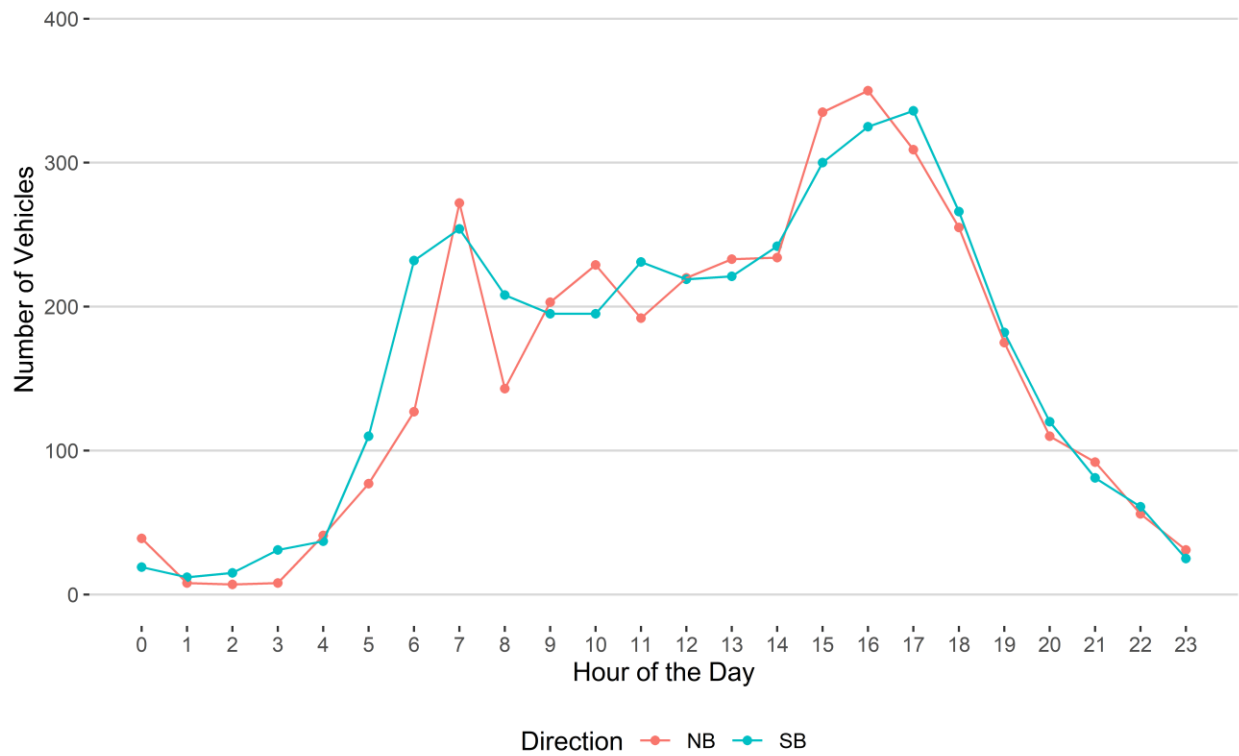


Figure 5 - Heavy Commercial Vehicles  
vs. Hour of the Day

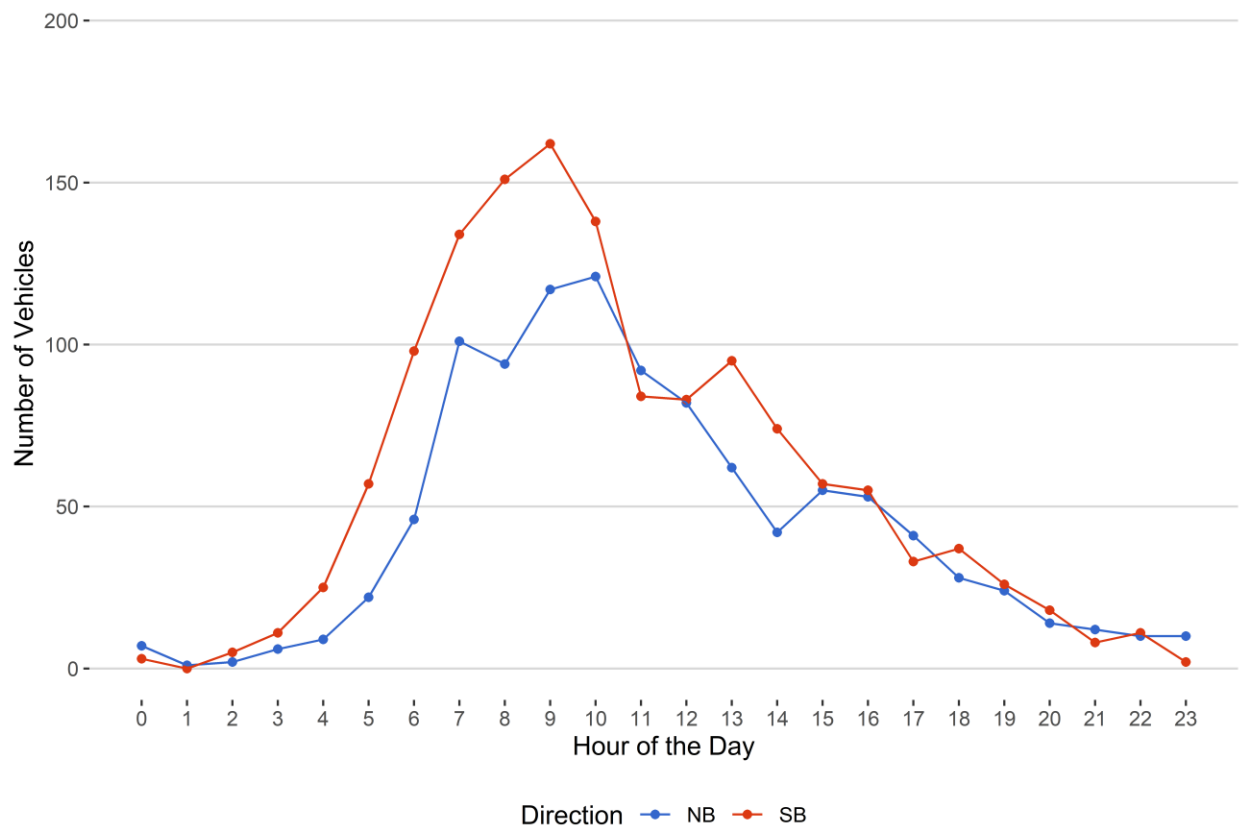




Figure 6 - Overweight Vehicles by Class  
vs. Hour of the Day

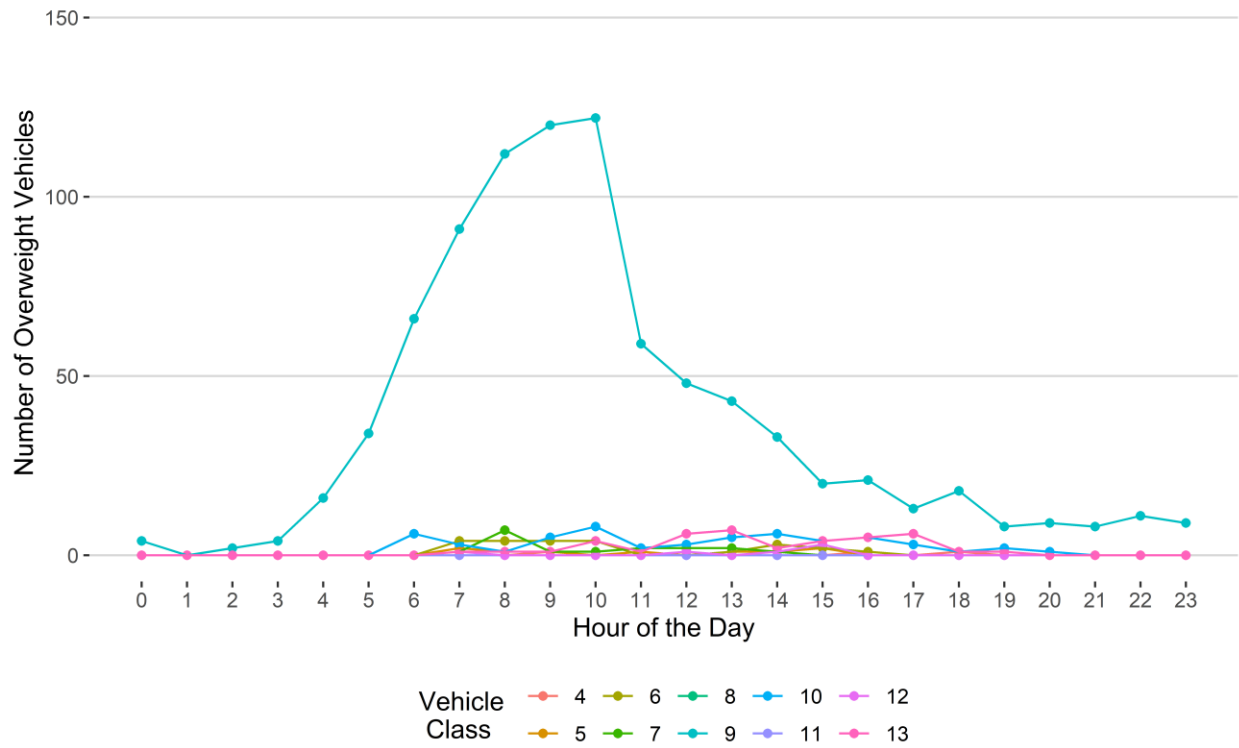


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

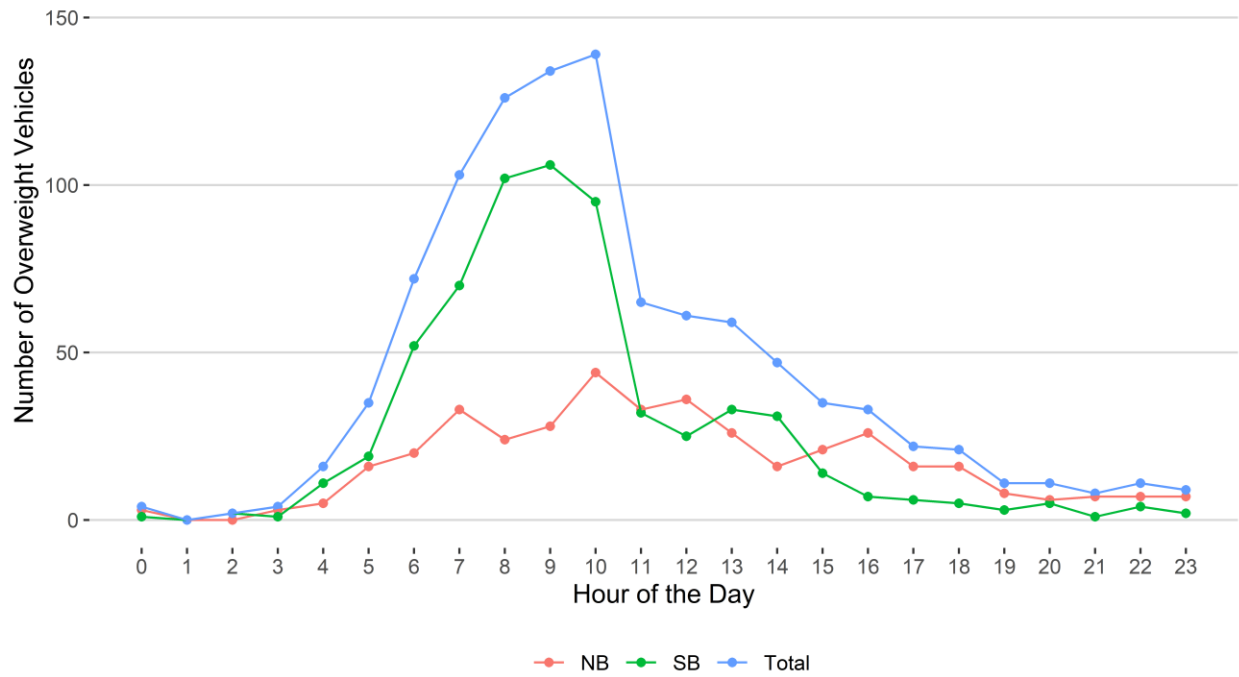
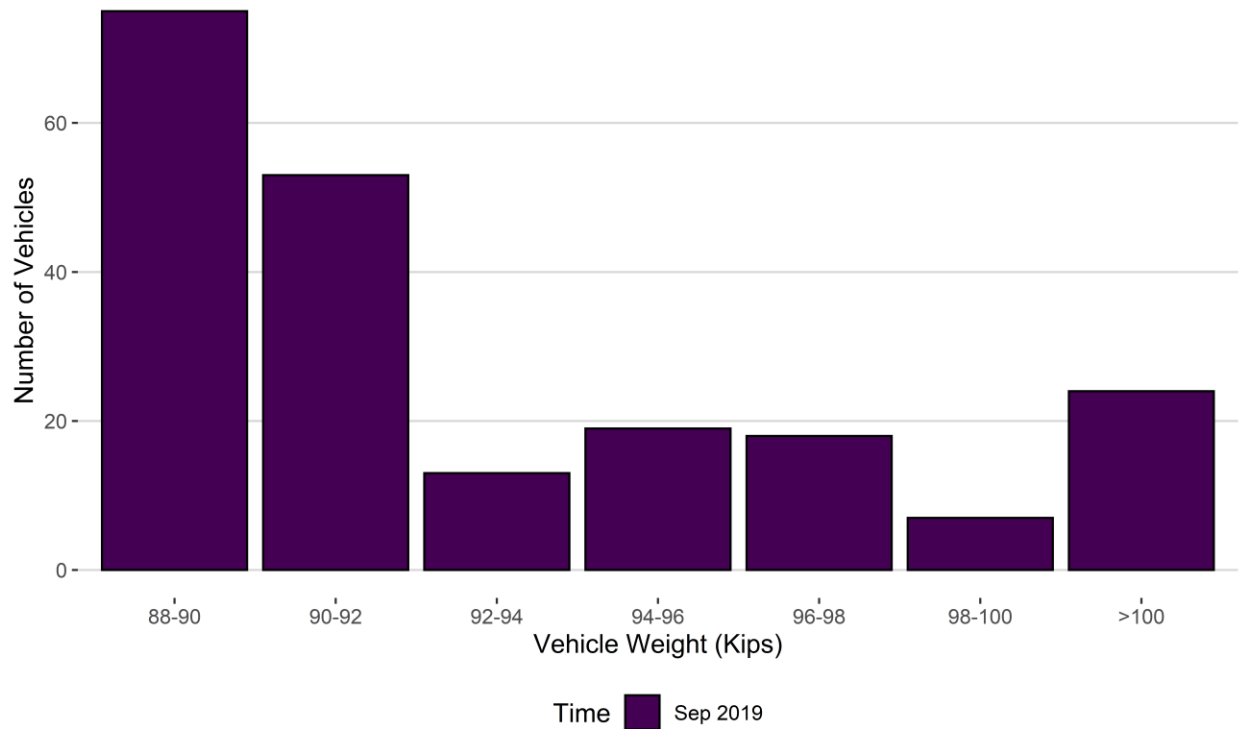
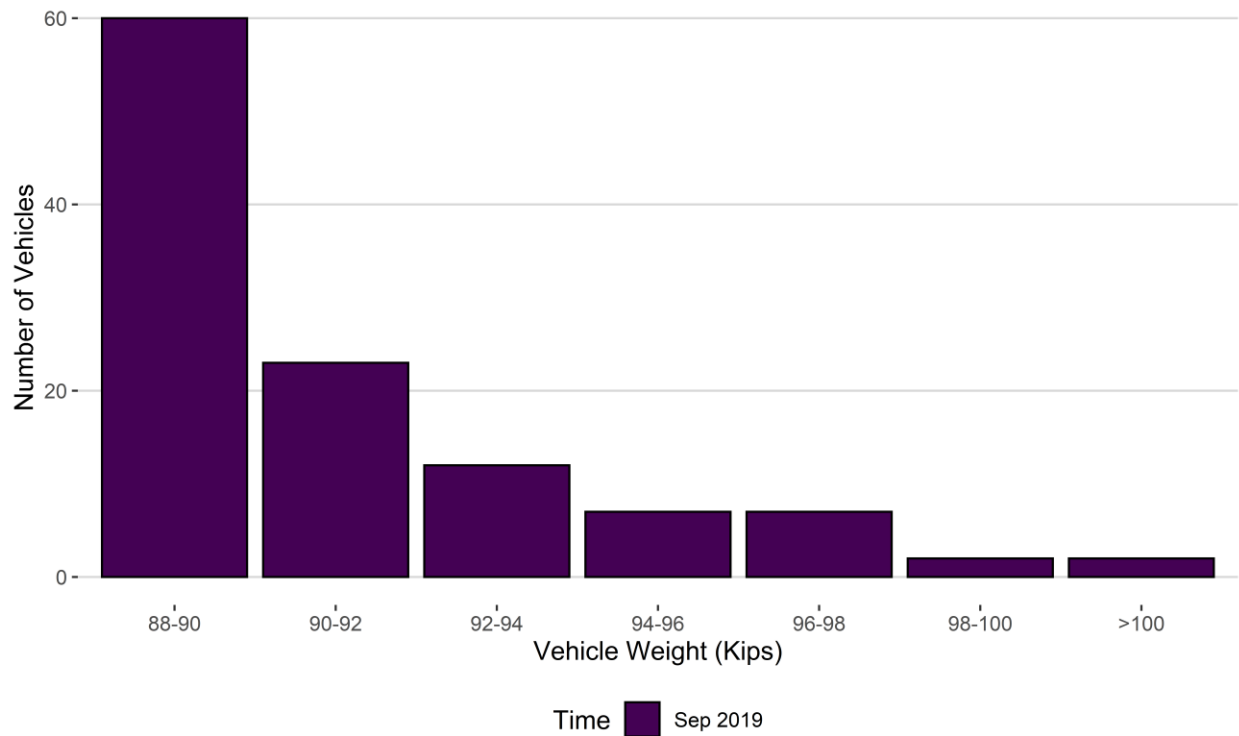


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>
88-90	75
90-92	53
92-94	13
94-96	19
96-98	18
98-100	7
>100	24
Total	209

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>
88-90	60
90-92	23
92-94	12
94-96	7
96-98	7
98-100	2
>100	2
Total	113

Figure 8 - Class 9's and 10's by Direction  
vs Gross Vehicle Weight

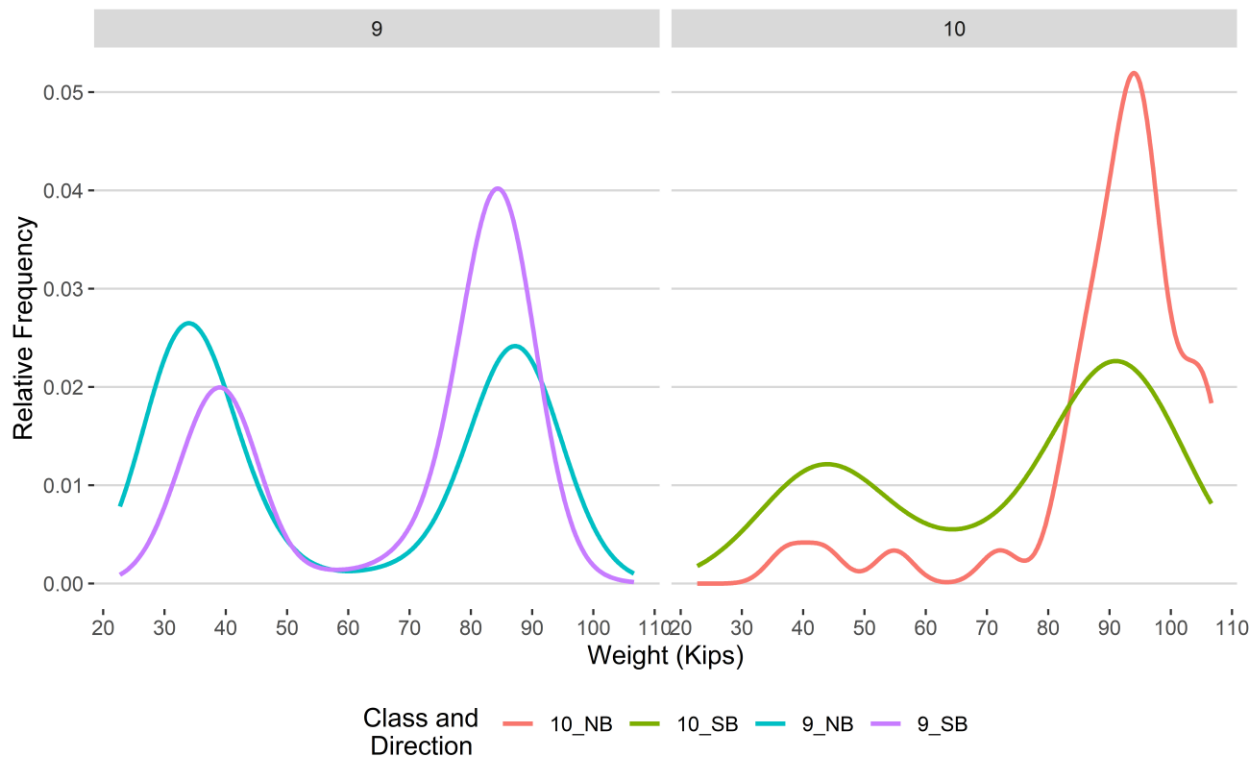


Figure 9 - Freight Percentage  
by Direction and Class

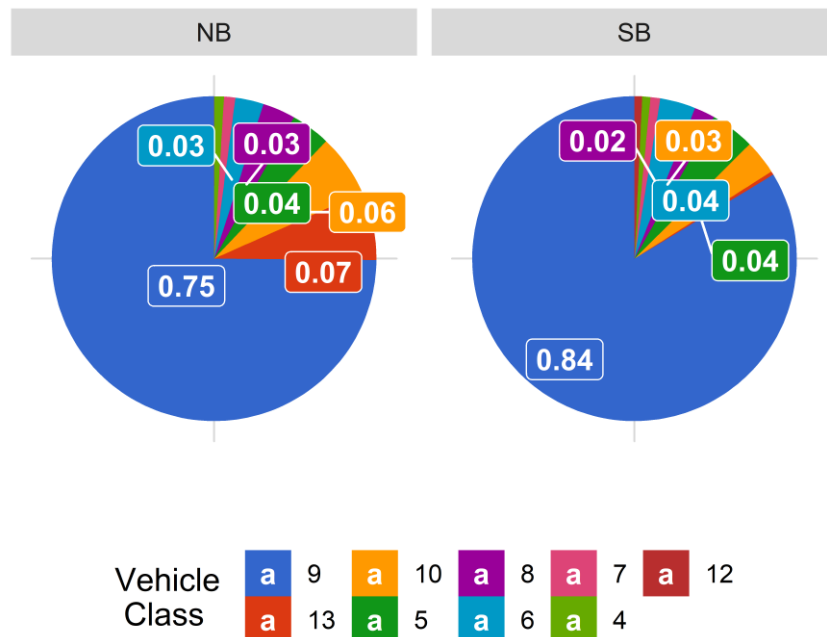


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

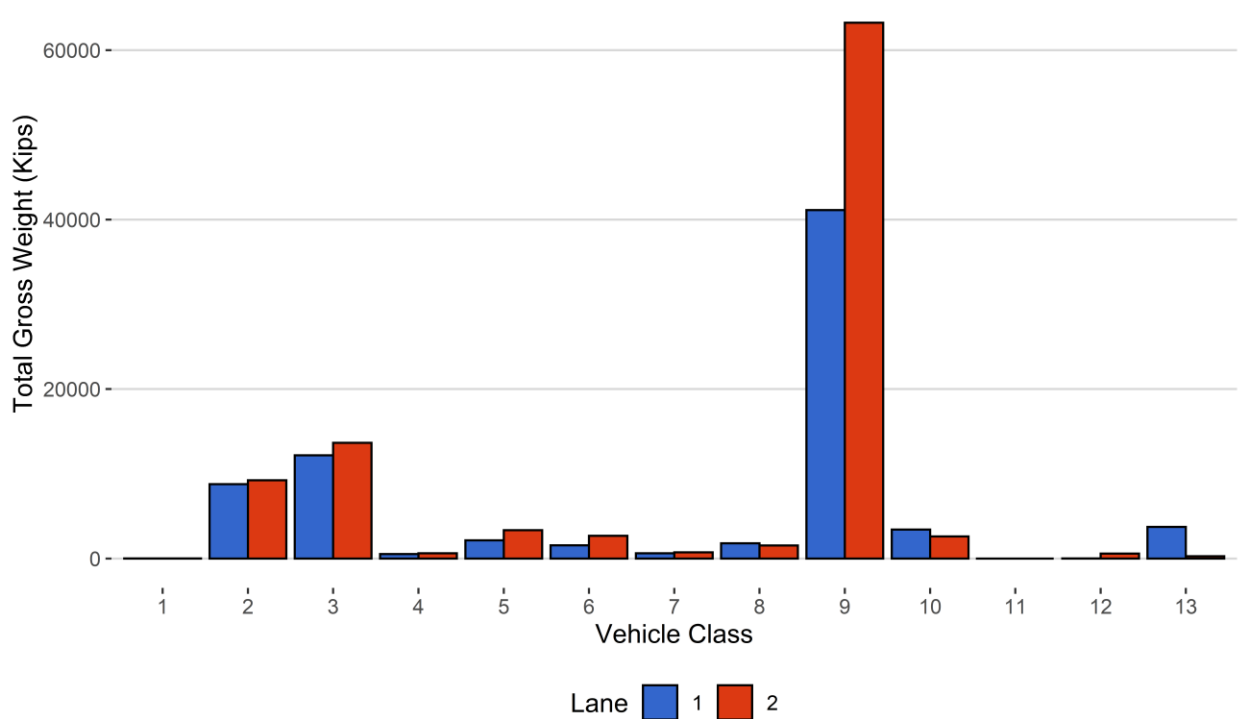


Figure 11 - Total Gross Vehicle Weight t

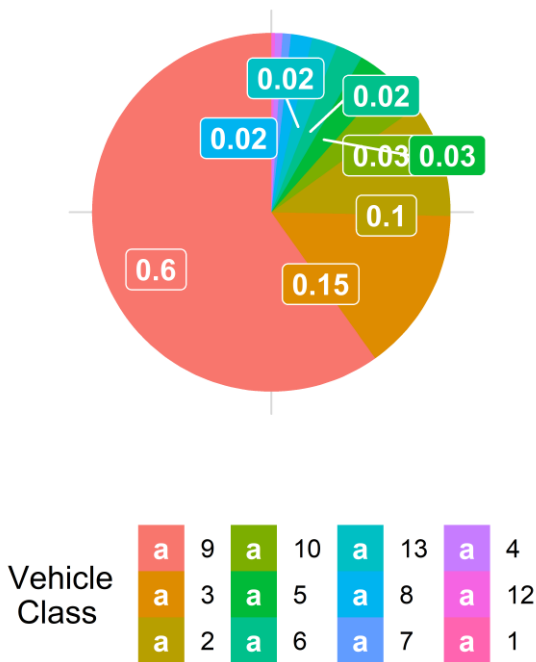


Figure 12 - Total ESALs by Class and Lane

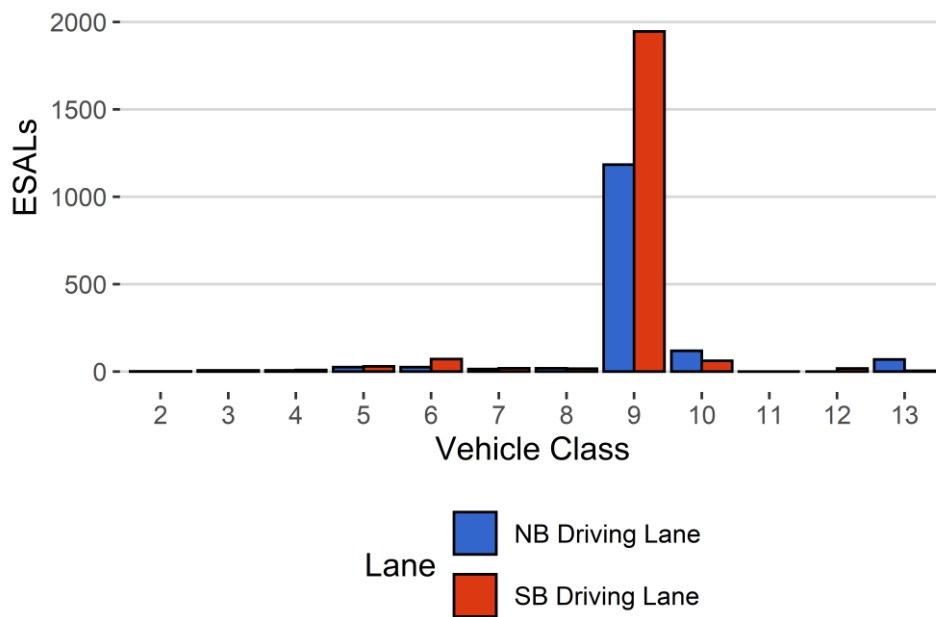
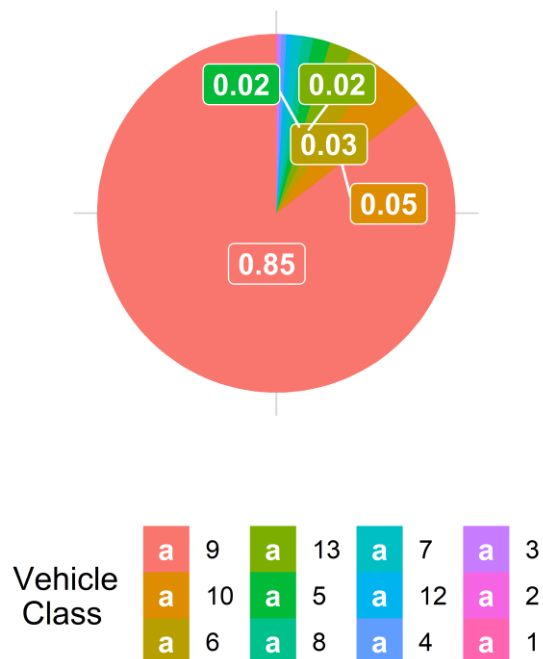


Figure 13 - ESALs by Class



**Table 1 Class 9 Front Axle Weight by Lane**

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
January 2017	9.68	0.00	9.86	0.00
February 2017	9.96	2.88	9.63	-2.29
March 2017	10.04	3.66	9.97	1.14
April 2017	9.39	-3.00	9.90	0.37
May 2017	9.78	1.02	9.93	0.74
June 2017	9.77	0.87	9.72	-1.39
July 2017	9.87	1.95	9.80	-0.56
August 2017	10.05	3.79	9.74	-1.21
September 2017	9.87	1.99	9.80	-0.60
October 2017	10.52	8.64	9.89	0.31
November 2017	10.50	8.46	10.34	4.83
December 2017	10.64	9.94	10.52	6.66
January 2018	10.77	11.21	10.50	6.47
February 2018	10.66	10.16	10.32	4.68
March 2018	10.59	9.41	10.14	2.82
April 2018	10.25	5.88	10.35	4.96
May 2018	10.10	4.32	10.14	2.79
June 2018	10.04	3.75	10.27	4.15
July 2018	10.31	6.49	10.11	2.51
August 2018	10.06	3.94	10.15	2.95
September 2018	9.86	1.84	10.35	4.97
September 2019	11.41	17.86	11.03	11.87



**Table 2 Vehicle Classification Data**

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	0	8	0.1	0	0
2	163	4880	41.2	0	0
3	137	4125	34.8	0	0
4	2	54	0.5	3	0.3
5	16	470	4	9	0.9
6	5	141	1.2	23	2.2
7	1	23	0.2	17	1.7
8	4	122	1	0	0
9	63	1884	15.9	871	85.1
10	3	86	0.7	55	5.4
11	0	0	0	0	0
12	0	8	0.1	6	0.6
13	2	48	0.4	40	3.9
<b>TOTAL</b>	<b>395</b>	<b>11850</b>	<b>100</b>	<b>1024</b>	<b>100</b>

**Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10**

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2019-09-07	Saturday	10:05:42	10	NB	1	114.02
2019-09-06	Friday	09:34:48	10	NB	1	106.62
2019-09-02	Monday	14:50:47	10	NB	1	106.05
2019-09-06	Friday	19:34:20	10	NB	1	105.8
2019-09-06	Friday	09:00:30	10	NB	1	105.78
2019-09-06	Friday	18:02:04	9	NB	1	104.35
2019-09-07	Saturday	10:30:56	9	NB	1	103.75
2019-09-09	Monday	16:34:36	10	NB	1	103.37
2019-09-06	Friday	15:46:10	10	NB	1	103.01
2019-09-24	Tuesday	08:27:36	9	SB	2	102.49

**Table 4 Freight Summary**

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	NB	15	22	8	36.4	410	112	100
5	NB	8	151	5	3.3	2119	36	476
6	NB	19	50	1	2	1532	18	300
7	NB	11.5	9	0	0	618	0	257
8	NB	31	55	21	38.2	1265	535	105
9	NB	33	687	149	21.7	36490	4642	9368
10	NB	33.5	38	0	0	3420	0	1074
12	NB	36.5	1	1	100	0	14	0
13	NB	31.5	38	0	0	3735	0	1269
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>1051</b>	<b>185</b>	<b>****</b>	<b>49590</b>	<b>****</b>	<b>12950</b>
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	SB	15	24	3	12.5	574	42	129
5	SB	8	250	6	2.4	3291	47	670
6	SB	19	70	2	2.9	2645	36	677
7	SB	11.5	11	0	0	734	0	304
8	SB	31	49	12	24.5	1342	205	98
9	SB	33	919	28	3	62362	884	16479
10	SB	33.5	35	0	0	2599	0	713
12	SB	36.5	6	0	0	573	0	177
13	SB	31.5	3	0	0	264	0	85
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>1367</b>	<b>51</b>	<b>****</b>	<b>74384</b>	<b>****</b>	<b>19331</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>2418</b>	<b>236</b>	<b>247</b>	<b>123974</b>	<b>6570</b>	<b>32281</b>

**Table 5 Gross Vehicle Weight by Class and Lane**

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	5	2	7	0
2	8774	9243	18017	10.3
3	12176	13662	25838	14.8
4	523	616	1138	0.7
5	2155	3338	5493	3.1
6	1550	2682	4232	2.4
7	618	734	1353	0.8
8	1799	1547	3346	1.9
9	41132	63246	104378	59.8
10	3420	2599	6019	3.5
12	14	573	586	0.3
13	3735	264	3999	2.3
<b>TOTAL</b>	<b>75901</b>	<b>98504</b>	<b>174405</b>	<b>100</b>
<b>GVW/LANE</b>	<b>43.52</b>	<b>56.48</b>	<b>100</b>	<b>0.06</b>

**Table 6 ESALs by Class and Lane and Flexible ESAL Factors**

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.125
2	1	1	2	0.1	0.0017
3	7	7	14	0.4	0.0089
4	8	10	17	0.5	0.77
5	26	30	56	1.5	0.29
6	25	72	97	2.7	1.61
7	15	20	35	1	2.87
8	20	16	36	1	0.72
9	1184	1946	3130	85.5	3.93
10	119	63	182	5	4.56
12	0	18	18	0.5	2.53
13	70	4	75	2	3.05
<b>TOTAL</b>	<b>1475</b>	<b>2186</b>	<b>3661</b>	<b>100</b>	<b>20</b>
<b>ESALS/LANE</b>	<b>40.3</b>	<b>59.7</b>	<b>100</b>	<b>-</b>	<b>-</b>

**Table 7 Site Summary: Volume and Vehicle Class**

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCADT</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>
Sep 2019	11850	400	95	9013	76.1	2836.7	23.9
<b>TOTAL</b>	<b>11850</b>	<b>-</b>	<b>-</b>	<b>9013</b>	<b>-</b>	<b>2837</b>	<b>-</b>
<b>AVERAGE</b>	<b>11850</b>	<b>400</b>	<b>95</b>	<b>9013</b>	<b>76</b>	<b>2837</b>	<b>24</b>

###ESALs

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Sep 2019	1475	2380	3855	21.5
<b>TOTAL</b>	<b>1475</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>1475</b>	<b>2380</b>	<b>3855</b>	<b>22</b>

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Sep 19	75928	98761	174689
<b>TOTAL</b>	<b>75928</b>	<b>98761</b>	<b>174689</b>
<b>AVERAGE</b>	<b>75928</b>	<b>98761</b>	<b>174689</b>

###Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Sep 2019	1028	10.2	42.3	322	35
<b>TOTAL</b>	<b>1028</b>	<b>-</b>	<b>-</b>	<b>322</b>	<b>35</b>
<b>AVERAGE</b>	<b>1028</b>	<b>10.2</b>	<b>42.3</b>	<b>322</b>	<b>35</b>

###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Sep 2019	12950	19331	32281	40.1	59.9
<b>TOTAL</b>	<b>12950</b>	<b>19331</b>	<b>32281</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>12949.8</b>	<b>19331.2</b>	<b>32281</b>	<b>40.1</b>	<b>59.9</b>